US Army Corps
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Ice Engineering

U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Ice Jams in Montana

An ice jam is an accumulation of ice in a river that restricts water flow and may cause backwater that floods low-lying areas upstream from the jam. Downstream areas also can be flooded if the jam releases suddenly, sending excessive water and ice downstream. Damages resulting from ice jams can affect roads, bridges, buildings, and homes, and can cost the affected community thousands to millions of dollars. More common, however, are jams that result in highly localized, yet serious damages (Fig. 1). In these cases, it is often difficult to obtain the types of disaster assistance that are available for large-scale flooding typical of open-water flood events.

Engineers at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) have been working to develop and optimize low-cost structural and nonstructural techniques to prevent or alleviate damages caused by ice jams. Many of these methods, such as early warning systems, ice dusting, ice breaking, ice weakening, and ice jam removal techniques, can be carried out by local offices at a reasonable cost (Corps of Engineers 1994). Methods of predicting ice jam occurrence and severity are also being developed.

The latter efforts, partly based on statistics and probability analysis, require the compilation of accurate and reliable data on past ice jam events. The CRREL Ice Jam Database was started in 1990 with the intent of compiling data on freezeup and breakup ice jam events in the United States (White 1996). Currently there are nearly 11,000 records in the database, with the earliest account dating from 1780. For each ice jam event, the database includes the river name, city, state, year, month, jam date, jam type, damages, a short description, a listing of publications, latitude and longitude, U.S. Geological Survey (USGS) hydrologic unit code, and USGS gage number, if available.

CRREL also has an Ice Jam Archive that contains hard copies of CRREL trip reports, National Weather Service (NWS) reports, newspaper articles, and other reports used as sources for ice-jam-related information (Herrin and Balch 1995). The information can be borrowed or photocopied.

Figure 1. Severe flooding on the Milk River in Glasgow, Montana, March 1986. (Photo courtesy of the Glasgow Courier, *Glasgow, Montana; used with permission.)*

Montana ice jams

This bulletin provides a brief summary of information in the CRREL Ice Jam Database for rivers in Montana. This is the second in a series that will characterize every state affected by ice jams using the CRREL Ice Jam Database.

Despite Montana's sparse population, with only 5.7 persons per square mile (Edstrom 1993), ice jams have a frequent and destructive history in the state. In 1992 there were 24,800 farms in Montana; ice jam floods often have left them inundated,

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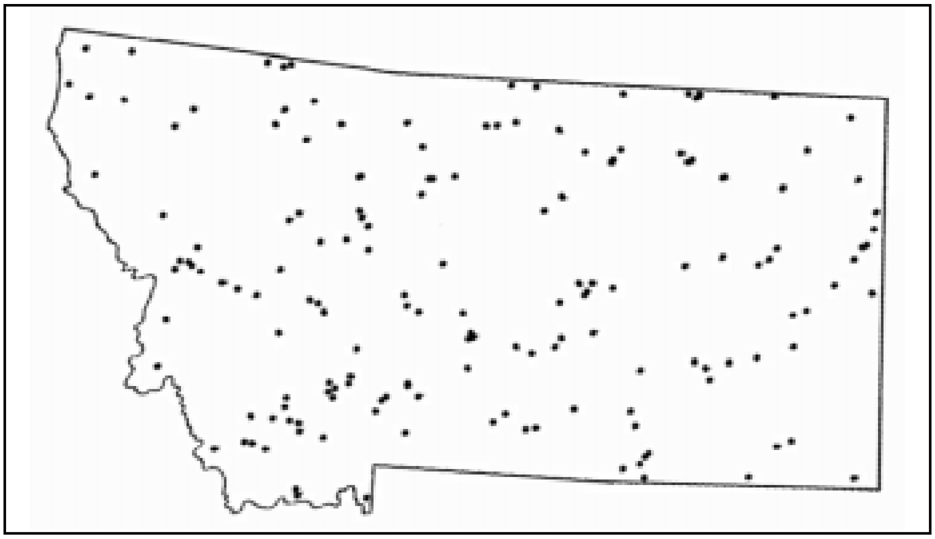

Figure 2. Known ice jam locations in Montana.

especially in lowland areas (Fig. 1). As of January 1998, there were 1039 Montana ice jam events documented in the CRREL Ice Jam Database (Fig. 2). The earliest entry in the Ice Jam Database for Montana is an 1894 event on the Yellowstone River at Glendive. The most recent entries are from ice jam flooding that occurred during 1997.

A substantial amount of the information on ice jams in Montana (about 80%) came from USGS Water Supply Paper 1679 (Patterson 1966). Other publications include NWS statements, Corps of Engineers' Datacols, other USGS publications, newspapers, and personal accounts. A recent trip to eastern Montana to review NWS records and collect additional historical ice jam data has contributed greatly to the CRREL Ice Jam Database and the Ice Jam Archive.

Where do ice jams in Montana occur?

The database contains information on ice jam events at 152 different locations on 119 different rivers in Montana (Fig. 2). The localities with the most recorded ice jam events (32) are Miles City on the Yellowstone River and Bozeman on the Gallatin River (Fig. 3). The towns of Nashua, Sidney, Zortman, Wolf Point, and Harlowton each have more than 20 recorded events in the Ice Jam Database (Fig. 3). The most ice jams reported for one river occur on the Missouri River, with more than 105 events, followed by the Yellowstone River with 88, and the Milk River with 81 events (Fig. 4).

It is important to note that the high number of recorded ice jam events on the Missouri, Yellowstone, and Milk Rivers compared to other rivers in the state reflects information gathered during field visits to that area in August 1997. There could be a river that experiences more jams than the Missouri River, but because there are few people living near the river, few if any floods or ice jams are ever reported.

When do ice jams in Montana occur?

The number of ice jams reported varies greatly from year to year, with the highest number (65) recorded in 1996 (Fig. 5). More than 50 events were also noted for 1951, 1959, and 1960. The number of ice jams reported in the database for certain years largely depends on the jam location and the availability of jam records. The number of ice jam events reported for Montana increased from the 1940s to the mid-1960s, most likely because of USGS Water Supply Paper 1679, which was published in 1966. Because this publication accounts for such a large portion of the Montana ice jam events in the database, it is no surprise that dates prior to its publication would have fewer recorded ice jam events.

Ice jam occurrence also depends on the time of year; 59% of Montana ice jams have occurred in March and April, when the rivers begin to break up, an indication that these ice jams are largely breakup ice events (Fig. 6). The 32% of jams that occur in January and February could be either freeze-up or breakup.

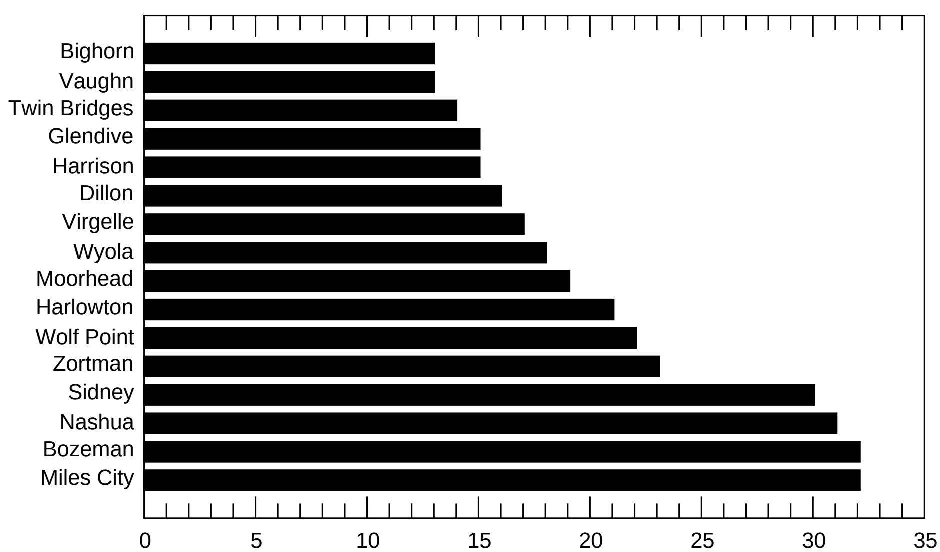

Figure 3. Montana cities with the most reported ice jams.

Who is affected by ice jams in Montana?

For Montana residents living near rivers, ice jams can be damaging to property, especially if not protected by a dike or levee. Agricultural damage due to ice jams has been particularly high in Montana. In 1972, an ice jam flood on the Yellowstone River in Richland County put an estimated 2500 acres of farmland under water (Anderson 1972). All this acreage suffered loss of fertilizer and there was some damage to fill ditches.

High waters caused by ice jams pose a threat to many of Montana's ranchers who may not receive sufficient warning to move their cattle to high ground. For Bob Heinle in eastern Rosebud County, the ice jam flood in 1994 was so rapid that he lost 60 cattle (Gaub 1994).

"It was just so quick, so devastating," Heinle said. "It came in the night before in a matter of 5 to 10 minutes. ... We put the cattle where we thought it was high ground. It wasn't high ground, as it turned out." According to Gaub (1994), the estimated loss in the dead livestock was $60,000.

Recently, concern has been expressed about the effects of ice jams on fish in Montana. Ice jams may affect fish populations because of physical displacement of fish, habitat destruction, and disruption of spawning activity (Gadbow 1996). In February 1996, the Blackfoot River ice run (Fig. 7) resulted in a significant fish kill with dead fish noted overbank. Ravens and eagles were observed eating fish in the overbank areas as well (Tuthill 1996a).

Another environmental concern is the Upper Clark Fork in the Bearmouth and Drummond area, where ice jam scouring releases soils contaminated with heavy concentrations of mining wastes that are toxic to fish (Gadbow 1996). In March of 1996, a substantial number of fish died in the Clark Fork River when ice jams and flooding forced the drawdown of the Milltown Reservoir. The fish fatalities were attributed to silt, debris, and toxic mining metals released from the reservoir area. Copper levels downstream from the reservoir were as high as 770 parts per billion, far exceeding the 18 parts per billion standard to sustain aquatic life (*Billings Gazette* 1996a). To provide additional information regarding the affects of ice jams on fish, biologists from the Montana Department of Fish, Wildlife and Parks in Missoula are monitoring some radiotagged fish in the Blackfoot River (Gadbow 1996).

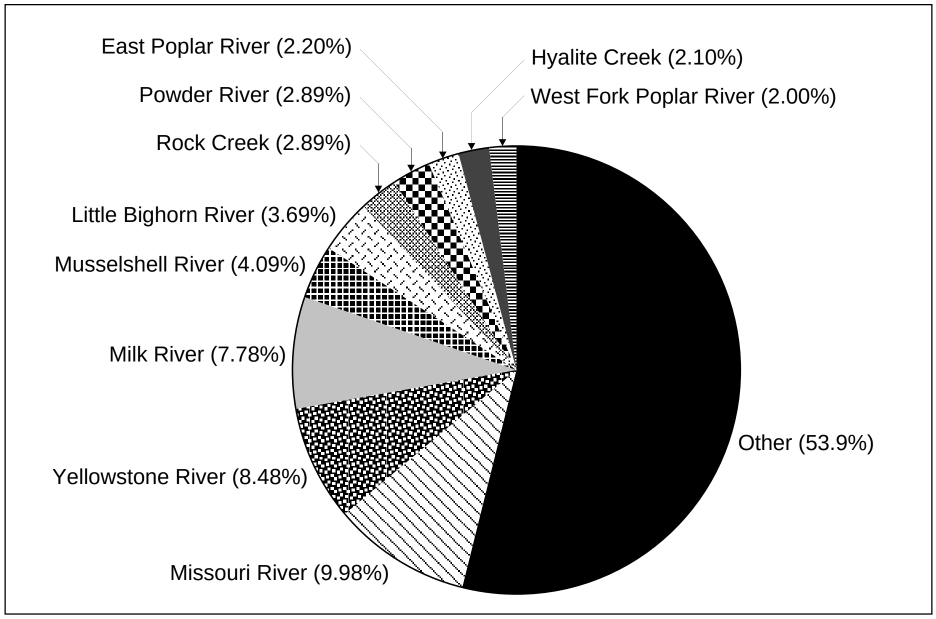

Figure 4. Percentage of known Montana ice jams on specific rivers.

Ice jam damages in Montana

As is the case for the database as a whole, many of the sources relied upon for information on ice jams in Montana lack quantitative data on damages. Of the 1039 Montana ice jam events in the database, 110 (10.6%) have known damages, a much higher percentage than the

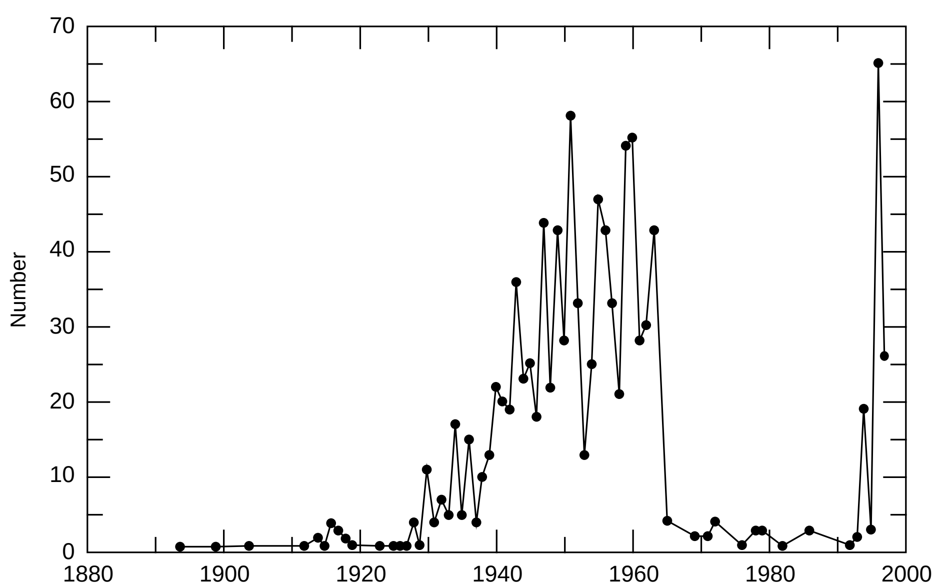

Figure 5. Ice events reported in Montana, 1894–1997.

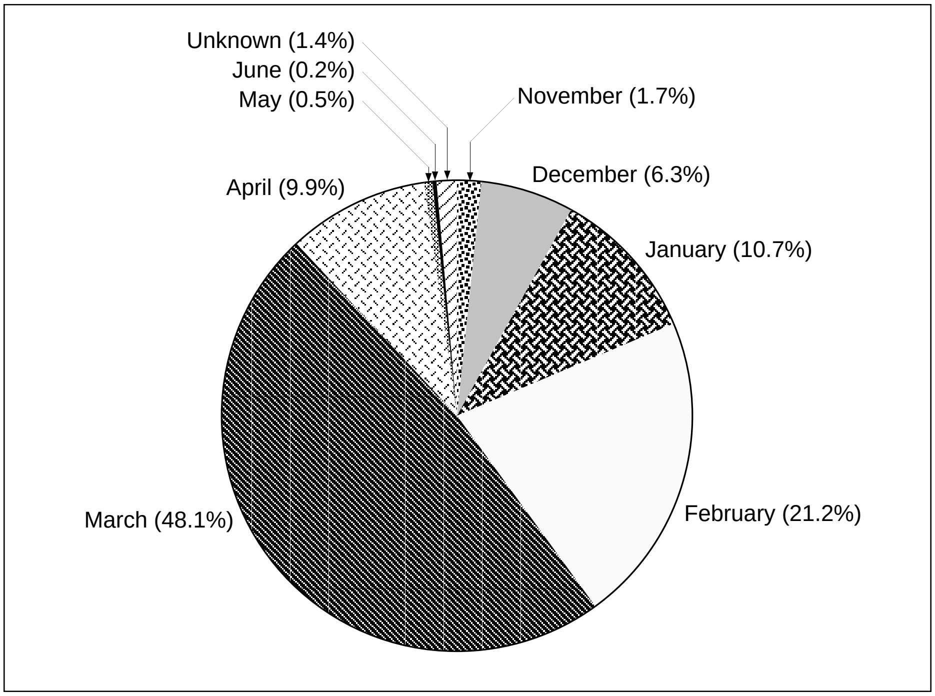

Figure 6. Months for which ice events are reported in Montana.

whole database (about 2%). The most common damages include bridge and residential damage, road flooding, evacuations, dike and levee damage, and agricultural damage.

Compared to other states, Montana has had significantly more deaths resulting from ice jam flooding. In February 1996 a volunteer in Fort Benton collapsed and died from a heart attack as he was helping to load sandbags (*Billings Gazette* 1996b). Two others died because of ice jam flooding in Montana in 1996 (*Billings Gazette* 1996c). In 1894 three men died while trying to escape ice jam floodwaters in the Glendive area (Tuthill 1996b). An 1899 ice jam in Glendive took the lives of the Sullivan family in their farmhouse on the west side of the Yellowstone River near Dry Creek (see box, page 5).

Mitigation costs incurred because of ice jams include evacuation, blasting, and other flood-fighting costs. According to local newspaper reports (*Miles City Star* 1997), "When nature didn't work fast enough, local pilots sometimes were called in to drop explosives onto the piled-up ice to prevent intense flooding." In March 1944, an ice jam on the Tongue and Yellowstone Rivers in Miles City caused 300 to 500 people to be evacuated from their homes. Local pilots were called in to drop fused dynamite explosive charges onto the ice jam.

According to the *Miles City Star* (1997), "Ice gorges [jams] were broken to a large extent and the charges are credited with having partially opened the channel of the larger stream." The crest of the flood was estimated to have receded two to three feet after the charges were dropped.

The first recorded flood in old Milestown (Miles City) took place in March 1881. The local newspaper (*Miles City Star* 1997) reports, "As Main Street began to fill with water, the novelty of the situation became clear and the flood became an unofficial water carnival. Dozens of boats, including an ancient flat-bottom boat, were soon cruising Main, supposedly to 'rescue' ladies from getting their long skirts wet. ... No lives were lost, and there was little property damage during that flood. Most people looked back upon that first flood not as a time of tragedy, but as unexpected excitement and a chance to pull together to help each other." The less adventurous residents of Milestown moved to higher ground, where they spent an uncomfortable week in tents, waiting for the flood waters to recede.

Figure 7. Aftermath of 1996 ice run on the Blackfoot River in Bonner, Montana.

Yellowstone River at Glendive—1899

Often a search of local historical records reveals ice jam information that is not contained elsewhere. One such example is the Yellowstone River flood at Glendive in April 1899, of which no mention was made in the usual sources. Discussions with local residents led to a search of old newspaper records which indicated that, in fact, twelve people lost their lives, numerous livestock drowned, many homes were washed away, and several spans of the Yellowstone River Bridge were destroyed during this event.

These types of historical records can be quite dramatic: according to the newspaper records, when the ice broke and began running on Friday evening, April 7, 1899, nearly the entire population of Glendive gathered to view the huge (nearly one hundred square foot) cakes of ice crush against the ice breaks (rock-filled timber crib structures) built in front of each pier on the Yellowstone River Bridge. Moments before the ice began to move, the water gage on the ice break registered 19 feet, but after the ice began moving the gage rapidly rose to 30 feet. After the ice run, three of the bridge spans had been washed downstream. Witnesses said that had the bridge been five feet higher, and had all of the ice breaks been built as large and as strong as ice break No. 2, the bridge would still be standing. At the time, the Yellowstone River Bridge was the largest wagon bridge in the entire northwest. It was 1750 feet long and included a draw span that was 326 feet long. The bridge, including approaches and ice breaks, cost Dawson County $50,000 to construct, and was estimated to cost at least $20,000 to rebuild (1899 dollars).

According to the newspaper account, when the waters started to inundate the land surrounding the Snyder Ranch, Mrs. R.W. Snyder, Miss Nellie Regan, Miss Rose Wybrecht, Mr. Eugene O'Conner, and Mr. Joseph Myers had to decide whether to move to higher ground (the railroad embankment) or to stay at the ranch. When they finally did make their decision to move to higher ground, which was approximately one block from the ranch, it was too late. The icy water was up to their waists before they made it halfway to the railroad embankment. Mr. O'Conner and Mr. Myers tried to assist the women into a tree, but the water and ice made it impossible, so they decided to tie Miss Regan and Miss Wybrecht to the tree with their suspenders so that the women wouldn't be washed downstream. Mr. Myers was able to climb the tree, but Mr. O'Conner and Mrs. Snyder were unable to climb to safety and were washed downstream, never to be found. Miss Regan and Miss Wybrecht were later found dead, still tied to the tree by the suspenders. Mr. Myers, the only ranch survivor, spent seven hours in the tree before he was rescued. The Snyder Ranch lost all of its livestock except two horses, one cow, two chickens, and two dogs.

The bodies of the James Sullivan family were found on Sunday, April 9, 1899. All were found in bed except the eldest daughter and one of the younger children, who were found on the floor. The eldest daughter's skull was crushed. It was presumed that she received the wound from a piece of ice while trying to battle the angry waters.

(The above information was edited from the *Glendive Independence*. The dateline for Saturday, April 8, 1899, appeared on the paper, although it was actually printed on Sunday, April 9, 1899, because of the ice jam.)

Corps of Engineers response

The role of the U.S. Army Corps of Engineers in Montana ice jam flooding has been to provide resources and technical assistance to alleviate flood damage to affected communities. The Omaha and Seattle Corps Districts have been involved in flood fighting efforts by providing technical advice, sandbags, and diversion dikes. In 1996, the Seattle District released a 1500-foot-long jam on the Lolo Creek using a hydraulic excavator (Tuthill 1996a). The Corps of Engineers also plays a role in monitoring the Glendive levee and the Miles City dike by providing technical reports and recommendations (Gratton 1997).

The Seattle District sponsored two emergency response workshops presented by CRREL in Missoula and Billings in 1997. The workshops, attended by more than 100 local, state, and federal officials, included discussion of local problem areas. A similar workshop was sponsored by the Omaha District in Omaha, Nebraska, in 1994. The workshop, which was attended by emergency management directors from across Nebraska, was designed to study ice jams and develop uniform guidelines for emergency directors to use when responding to those emergencies.

How is ice jam information helpful?

The Ice Jam Database provides quick access to general information about specific ice jam events, an important feature for those interested in the ice jam flooding history of a certain area. These historical data are crucial during an emergency situation when information about jam locations or stages is needed quickly. Historical information is also important for ice jam mitigation studies at specific sites. This overview of ice jams in Montana is the second publication in a series that will attempt to characterize all states

affected by ice jams. The aim is to highlight ice jam trends for every state.

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Please send any information for inclusion in the Ice Jam Database and Ice Jam Archive to Lourie Herrin, Ice Engineering Research Division, CRREL, 72 Lyme Road, Hanover, New Hampshire 03755-1290. Originals can be photocopied and returned.

The CRREL Ice Jam Database is available via CRREL's Website (http://www.usace.army.mil/crrel/icejam). It is also available on CD-ROM by contacting CRREL's Ice Engineering Research Division at 603-646-4378.

This issue of the Ice Engineering Information Exchange Bulletin *was written by Heidi J. Eames, Engineer Aid; Lourie A. Herrin, Research Program Assistant; and Kathleen D. White, Research Hydraulic Engineer, of the U.S. Army Cold Regions Research and Engineering Laboratory. Ms. Eames, a student at the University of Vermont, has worked on the CRREL Ice Jam Database for four years. Ms. White has been involved in all phases of the database, including design, data collection, and statistical analyses. Ms. Herrin has been involved in data collection and input since the early 1990s.*

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Ice Engineering Information Exchange Bulletin

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BARBARA J. SOTIRIN, Ph.D.
Director